

**Further steps of the  
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# FURTHER STEPS OF THE RESEARCH ON ARCHAIC CRAFTS FROM SARDINIA TO ETRURIA

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**RESUMEN:** Un estudio reciente de documentos sardos y etruscos tempranos (o villanovianos) ha permitido identificar algunos tipos de embarcaciones y sus principales rasgos estructurales. Esta identificación fue posible al proceder por etapas, empezando por las embarcaciones de fondo plano y ampliando luego la investigación a las embarcaciones con casco redondeado; aquí se presenta la interpretación más reciente de las formas y los tipos de barcos sardos, que completa la evaluación de los modelos en bronce nurágicos. Algunas figuras de bronce sardas se han datado como pertenecientes a la Edad del Bronce Antiguo (siglos XIII-XII a.C.), respaldando así las comparaciones con el mundo egeo. El método de moldear los modelos para su fundido en bronce y de refundir los componentes arroja nuevos datos sobre cómo se interpretaban las figuras de barcos.

**PALABRAS CLAVE:** embarcaciones de fondo plano, cascos redondeados, sardo, villanoviano.

**ABSTRACTS:** A recent review of Sardinian and early Etruscan (or Villanovian) documents led to the identification of several types of crafts and their main structural features. Such identification was possible in stages, starting from flat-bottomed crafts. Research was then extended to round-shaped hulls; the latest interpretation of the shapes and types of Sardinian ships, completing the evaluation of Nuragic bronze models, is presented here. Several Sardinian bronze figures have been dated to the early late Bronze Age (XIII-XII cent. B.C.), thus reinforcing comparisons with the Aegean world. The method of moulding the models for bronze casting and of overcasting the parts provides further information on how the figures of ships were interpreted.

Sardinian bronze ship models still appear like erratic stones, as no wreck of their times was found; they come after an earlier development which we can induce only from indirect documents and from comparisons. Configuration of the landing places, tools, buildings, distribution of artifacts, consideration of the ambience and boats figures (Grabak), models and dugouts (Egypt, Bracciano) and ethnographic similarities (Shri Lanka, India) allow to induce the technical level of Neolithic crafts. In the Calcolithic period woodwork and the control of shapes and dimensions of buildings provide with further clues showing more possibilities to build seagoing crafts.

Nuragic bronze figures suffered from a process of idealization, after which, around the VII Cent. B.C. they appear to have been substituted by clay objects, similar to Villanovian models, where the technical level of reproduction of the original crafts had conflicting and generally unrealistic results. Notwithstanding these difficulties, no less than five types of early Etruscan crafts have been identified, with more connections to the Aegean than to Sardinia. A clue for the problem of archaic building techniques is provided by tenons and pegs connection of the VIII - VII Cent. B.C. box in Verucchio.

**KEYWORDS:** flat-bottomed crafts, round shaped hulls, Sardinian, Villanovian

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## SARDINIAN DOCUMENTS

There is a wide literature on the Nuragic bronze ship models, as they have been rising a huge interest, but only recently they have been investigated in nautical terms (among the others: P. Filigheddu, 1987-92; A. Göttlicher, 1984; F. Lo Schiavo, 2000; A. Depalmas, 1996; Bonino 1984, 1989, 2001). Now the classification of the two main categories (flat bottomed crafts and round hulls) can be completed with single and multiple wales, round hulls having obliquous and vertical stempost with rounder shapes of the lines of the hull and different types of main sections.

*Flat Bottomed Crafts*

The growth of sewn shells around the basic structure of a flat bottom resulted in boats with angled posts and straight sides; there are cases of rounded sides, as a possible result of an influence from round shaped hulls, but elements are not sufficient to define this connection. The smaller specimens have a reinforcement in correspondence of the junction between the bottom and the sides and another wale (the topgallant bulwarks or a similar structure) surrounding the tops of the sides. Bindings or stitchings appear outside both structures, and they are realistically represented, like the connections between the stempost and the animal head shaped *akrostolion*. The reconstruction of this type of craft is not new (M. Bonino, 1984, 1989, 2000, fig. 1 A), now we can go into some details of the bindings of the wale, most probably transverse and coming to the outer surface of the structure. It is an archaic type of binding, which has the risk of being damaged by friction with the sand or with the gravel of the landing place and it provides also a way of penetration of water inside and of soaking the stitchings, if not carefully covered by pitch. But they were used in examples ranging from Castione (Bronze age), of the wreck of Nin (I cent. A.D.), or ethnographic documents in Northern Europe, India or in Indonesia (BAR, 1985, p. 67-85, 200, 303 sgg., 345 sgg.).

Larger crafts had taller sides, which needed to be further reinforced with intermediate wales. The shape and the size of these crafts make it improbable that only one strake of planking was put between the wales; this space must have been filled with two or more boards sewn from the inside, as we know from more recent archaic wrecks. This builds a combination of transverse (planking/wale) and obliquous holes (planking/planking) and stitchings, respectively visible and not visible from outside (fig. 2).

The shape and the position of the double wales on the sides of the boats, with a narrow topgallant on the top, suggest that the wale, originally cylindrical, could have had two opposed rabbets: this would allow a good and strong connection. The angles of the rabbets and of the incoming edges of the boards can be adjusted to fit and to compensate for the shape of the outer surface of the shell, both in the case of the flat surface of the sides and for the angle between the flat bottom and the sides.

There is no clue about the presence of a mast and of sails; the assumption about oaring only is still valid due to the lack of any precise mention to the mast: the suspension devices are arc shaped, with no vertical part recollecting the presence of a mast, which, on the contrary, is quite common in round shaped boats.

The shape of these flat bottomed Sardinian models had probably an origin common to that of some Villanovian terracotta models, where the longitudinal reinforcement at the edge of the flat bottom is evidenced and it ends, in some cases, with a handle of the pot-

tery object (G. Pettena, 1998: Tarquinia, Museo Nazionale, Inv. RC 249, RC 263). The shapes of these early Etruscan sculptures are very much distorted, to fit with the function as votive tools or lamps, therefore it is difficult to use these documents for nautical archaeology. Others are more meaningful and they will be discussed later.

### *Round hulls*

The general structure of round hulls can be deduced by applying the general principles of archaic boatbuilding (*sutiles naves*) which are represented more clearly by flat bottomed crafts, belonging to the same material culture.

The shapes of these bronze models are heavily idealized, so that it is not easy to induce how the ships were originally; comparisons with reproductions of different artifacts, such as Nuragic fortresses, huts, or even warroirs, confirm a general shortening and a geometric simplification of the figures, in connection with much taller proportions (E. Contu, 1999; A. Moravetti, 1980). This is common to all ancient figures, but angles, curves, sections and slopes are normally realistically reproduced from those of the original ships; for this reason, as done for the flat bottomed crafts, it is possible to propose the main aspects of their profile, plan and sections. The upper part of the stern and the keel are never represented and the round bottom in many cases was flattened to let the model stand, even though this does not affect too much the interpretation of the original sections. The topgallant bulwarks, the fence and the partial deck abaft are well represented, with emphasis to the *akrostolion* and in some cases to a support on the fence astern to put the steering oar; the mast is included in the suspension device, but in some cases it is individually reproduced and shrouds and stays are suggested.

The difference between flat and round bottomed models is stressed also by the technique of fixing the posts: flat bottomed models have a tube joint which is covered by the thread windings representing the binding of the animal headed *akrostolion* to the stempost; in round hulls the *akrostolion* with the partial deck is overcast on the upper bow end of the hull.

Even if distortions or lacks of details are evident, the quality of these bronze figures is high and it shows the care we have noticed with the flat bottomed models, but with a higher degree of idealization and this suggests that these models are more recent and far from the originals.

In this analysis the so called heart shaped bronzes are not considered (P. Filigheddu, 1987-92, p. 81, fig. 6, Tab. 2/a, N. 1, 2, 75, 100; A. Depalmas, 1996, fig. 1A), as they are clearly interpretations of the ship or of the boat (if this is the case) to shape objects not connected with floating crafts. Similarly some Villanovian terracotta models belong to this category (G. Pettena, 1998: inv. Museum of Tarquinia RC 249, RC 263, 83489/f) and it is more prudent, from the nautical standpoint, to exclude them from this analysis.

The first reconstruction proposed in 1998 for round hulls refers to hulls having oblique stemposts and round cross sections (fig. 3) as shown by bronze models, by the Bon Porté (P. Pomey, 1981) and by the Golo (A. Paris, 190, V, pl. 241; L. Basch, 1987, N. 226, p. 117) wrecks.

The curved line of the upper edge shows that flexible lists of wood were used to shape the sides; this procedure appears to have been common to many Nuragic ship models, as the line of the sides is an elliptical development of a circle drawn on the main section of the hull. This geometric development proved to have resulted from bending the

planks since Egyptian shipbuilding and its rationalization was a possible geometric tool used by nautical architects in classical times (M. Bonino, 1997; M. Bonino, 2003, p. 97).

This does not mean that the Sardinian shipwrights used by sure this geometric approach with ruler and compass to control the shape of their ships, but it suggests that the usage of the flexible wooden lists for the models could have been conceptually common to the procedures to shape the curve of the sides of the actual ships, after having defined the widths of the hull in the middle and at least in other two sections of the hull.

The bent lists were the basis for forming the wax moulds for these bronze models, with a technique similar to model crafting (fig. 4).

A flat basis was prepared, there are cases of flat bottomed models which were shaped on a curved basis to reproduce the sheer of the upper edge, but generally the basis was carefully flat. Two flexible wooden lists nailed against the basis at their ends and in the middle provided the mould for the sides (fig. 4 A); the height of the lists corresponds to that of the topgallant bulwarks of the models and it is carefully straight, in order to obtain a regular dimension and shape of the edge. In some cases the wale at the upper edge is not represented and all the hull is smooth, but the technique was similar also in these cases. Wet clay was put between the bent list to shape the hollow of the hull, with the precaution of leaving the correct distance to the lists in order to obtain a regular final thickness. After careful shaping of this matrix for the inner hollow, the wax was poured on the mould to have the correct thickness of the final hull and to fill the gap between the lists and the core; forming followed as in normal sculptures and the thicker topgallant bulwarks were obtained by passing a spatula along the edge of the wooden list. The fences, which in some cases are quite elaborated, appear to have been added to the initial wax mould just before preparing the final shell in terracotta.

Wales of flat bottomed hulls were added to the initial wax model by sticking rolled wax cylinders to the hull and, if the cases occurred, by carving them to imitate the stichings. Rising parts of the bows or the supports for the *akrostolia* were added to the first wax mold in this phase.

At this stage the wooden list were taken out and the final mould for casting was formed with clay around the wax model, then it was baked in oven for the lost-wax casting, taking care to prepare inlet and exhaust channels for discharging the liquid wax, for casting the bronze and for letting the air escape during casting (G. Ugas, 1989).

After the main part of the hull was cast, other details prepared before were added by overcasting: the *akrostolion* together with the partial fore deck, the mast and the suspension ring and, in some cases, also the fences with the columns or the ornamental details over them.

This category of hulls has been thought as having a round main section, but in other instances the shape of the main cross section is more developed, with tendentially angled and rounded sides connected to the bottom with a slightly sharp curve, which provided the crafts with a better seaworthiness. Similarly flat bottomed crafts had not always straight sides, but we can see a definite curve, which makes the section and the shape of the hull quite similar to that of the round shaped hulls under discussion (fig. 5). It appears therefore that also during Nuragic times there was an interaction of shapes and features between flat and round hulls, as it happened in most of cases when the two types of crafts were used contemporarily.

The second category of round shaped hulls is slightly different: the stempost is generally perpendicular, but the ends are a rounder shape in plan, belonging probably to a sturdier type of hull. To shape the wax mould for this type of models the same technique

described before was applied, with the addition of round profiles at the ends of the pattern made with the bent wooden lists. In one case (fig. 4, D) it is possible to recognize the discontinuity due to the addition of this profile and the consequent finishing of the prow area (Depalmas, 1996, fig. 9, Scala de Boes, Ploaghe - Sassari). The rear parts of the models do not supply much information, however we can compare the shapes of the lines, such as the profiles and the main cross sections (fig. 6), as they appear rather realistic.

Recent research tends to anticipate the date of the early bronze models to the XIII-XII Cent. B.C. (G. Ugas, 1989; F. Lo Schiavo, 2000) with two consequences: proposed comparisons with Aegean and particularly Mycenaean documents is reinforced, secondly Sardinian models appear older than the known Villanovian ones, which are not older than the IX Cent. B.C. Sardinian models have been made for some centuries, apparently starting from flat bottomed crafts and ending with the most idealized shapes of round hulls; the end of these figures appears to have come just before or around the VII Century B.C., when terracotta models were made also in Sardinia. Documents of this phase are no less than 300 specimen found in the shrine of the nuraghe of Su Mulinu (G. Ugas, 1990, fig. 9), probably kept as *ex votoes* (fig. 6). The quality of these figures is much worse than that of the bronze models, with a huge gap of shapes and techniques, which so far has no complete explanation: we can assume that from IX to VII Cent B.C. a new sense of the shape of ships transferred to other object was spreading around the coasts of the Tyrrhenian Sea, influencing eventually an area where previously more refined and realistic models were made in bronze. The interpretation of the shapes of bronze models appears to have been lost or forgotten, although they were still visible, as they were appreciated, and put in tumbs and shrines as antiques, or *status symbols*. The idealization was then brought to extreme consequences (M. Cristofani, 1985, N. 3.9, p. 99), on both sides of the Tyrrhenian Sea, with detrimental effects for our nautical researches.

Coming back to bronze models, the comparisons with Aegean ships, suggested since long, becomes stronger, as the initial period of Sardinian bronze models is contiguous to Mycenaean direct influence, which is confirmed also by the frequency of Mycenaean finds in Sardinia and by the strong links with Cyprus (F. Lo Schiavo, 2000; M. Gras, 1980; F. Lo Schiavo, F. Macnamara, E. & L. Vagnetti, 1985).

Flat bottomed crafts appear as definitely local: Minoan and Mycenaean flat bottoms (L. Basch, 1987, N. 225; A. Göttlicher, 1978, N. 335) can be compared on a functional, but not cultural basis; while the comparison of later Villanovian and Etruscan figures of flat boats is possible, as they can be connected both geographically and culturally with Sardinian crafts (fig. 1B, 8). Comparisons of round hulls fit much better with Aegean documents, confirming a common technical background, from Minoan and Mycenaean figures, to the later wrecks of Golo and Bon Portè.

Since the Middle Minoic period the shape of a crescent like hull is recognized through seals and paintings (L. Basch, C 9, C 11, C 12, p. 101, C 15, p. 102: Minoan seals; N. 224, p. 114, Hagia Triada, RM II): Thera frescoes and the sarcophagus painting of Hagia Triada; later, between 1300 and 1200 B.C., we have the appropriate comparisons of a series of small clay models (National Mus. Athens, Inv. N. 3099; model from a tumb in Tanagra, Thebes Museum, L. Basch, 1987, N 292, 293). The important details of these clay models are the inner paintings representing the keelson and the ribs, while the outer surface has a horizontal pattern, sometimes stressed with vertical marks, which can be interpreted as bands similar to those painted on the sides of the model represented on the Minoan sarcophagus of Hagia Triada.

Also ships with perpendicular or tendentially more vertical posts are proven to have been present in Minoan culture (C. Laviosa, 1972, p. 11 – 13, fig. 3°, b, d; p. 27-29, fig. 27. 3d; L. Basch, 1987, 273, p. 133, 274). a vase from Phaistos and a clay model from Hagia Triada both dated LM III, or the famous vase from Skyros being the most direct comparisons (L. Basch, 1987, N. 295). They have the stempost connected to the keel with a sharp curve; these ships have an ornamental band stressing the upper part of the sides. The Hagia Triada clay model was not much studied, but it is very interesting: it has a continuous deck, benches over it, a mast and a seaworthy shape (fig. 7).

Sardinian bronze models appear to have been the local interpretations of these Minoan and Mycenaean types, and their permanence can be explained with the distance from the original area and the economic conditions: the usage of elder models coming from a direct influence from the East continued longer, also when the original shapes in the Aegean were changed into new types of ships, because the tradition and the economy in Sardinia were different and not so strong as in the homeland. When the situation in the East developed further, new types of ships were used also on the Western Mediterranean, but they affected only the representations in the Villanovan area. I suggest that this is the reason why types with the protruding keel at the ends, so common in the Aegean, were not represented in Sardinia, but they were in Etruria (fig. 8A).

There were obviously sturdier and rounder hulls, as suggested by the Hagia Triada clay models or by the later Homeric quotations (Od. V, 243-259), but in the case of Sardinia clues are more vague. Ethnical classification of ships of this archaic period, although suggested by some scholars (L. Basch, 1987; V. Guerrero, 1998, 2002-2003 forthcoming) are similarly very difficult: there were certainly differences among Sardinian, Villanovan, Mycenaean or, later, Phoenician ships, but now we cannot tell which those differences were. Suggestions may come from the early usage of *gomphoi* and *harmoniai* (pegs and tenons, or *poenicanum coagmentum*) or from the shape of the *akrostolia*, like the duck and griffon for Villanovan ships, the deer or bull for Sardinian crafts or the bronze bull for Balearic ships (V. Guerrero, 2002-2003, fig. 14), but the recent finds in Su Mulinu (G. Ugas, 1990, p. 563, fig. 9) show that this was not so strict.

#### EARLIER CRAFTS IN SARDINIA

We have some indirect clues about the shapes and the technical level of the crafts used earlier in Sardinia, which may be worth considering in this frame (Exhibition, 1985, p. 14-15). The distribution of artifacts in Sardinia through the Neolithic, Chalcolithic and Bronze periods is concentrated mainly on the axe Cagliari Oristano and on the areas of Olbia–Olivenza, up to Alghero and Coghinas. The shores of these areas are good for landing and fishing, as they had mouths of rivers and lagoons where flat bottomed crafts developed (M. Bonino, 1981, 1982).

The presence of such landing places in areas fairly well protected from the adverse winds (mainly Cagliari, Oristano and Olbia-Posada-Orosei) made them favourable for the ships coming from other parts of the Mediterranean. These incoming and outgoing movements can be reconstructed since the very beginning of the settlements in Sardinia, or at least from the Neolithic time.



We can consider for this purpose:

the early settlements in Sardinia coming from Corsica, Clactonian episode, then continuously from the VII millennium B.C. (G. Lilliu, 1985, p. 15).

the export of obsidian from Mount Arci, to all Northern Thyrrenian and Ligurian Sea, up to Provence, and the contemporary distribution of Neolithic artifacts particularly those between Cagliari and Oristano areas (Lilliu, 1985, p. 20, pl. 1).

the nature and the details of calcolithic artifacts (*domus de janas*, 2700 – 1800 B.C.)

the connections with the Mediterranean in the same calcolithic period (distribution of bell shaped vases), confirming the usage of landing places and of the waterways for penetration inland (S. Tusa, 1983, p. 240, fig. 27).

But, if the facts are known, it is difficult to extrapolate from them which were the types of crafts used for such trades. Documents useful for nautical studies are rare and difficult to interpret. Suggestions for technical solutions come from the general features of woodworking in the Neolithic, by some archaeological finds, some figures and by ethnographical comparisons.

#### HYPOTHESES ON NEOLITHIC CRAFTS

Most probably the primigenious craft in our areas was the raft or the bundle of reeds, as we can assume from the history and traditions of shipbuilding in Italy and all around the Mediterranean (M. Bonino, 1981, J. Hornell, 1946- ed. 1970). The assumption that neolithic crafts could have been similar to the traditional *fassoj* of Cabras lagoon is correct from the evolutionary standpoint: the capability to bind reeds in a sophisticated way is shown by some clay works inprinted with the patterns of the baskets or of the mats (Puistèris, Conca Illònis, G. Lilliu, 1967, pl. III, b, pp. 20-21). Such reed boats could have been used locally in lagoon areas and a continuity from the Neolithic to the present time appears as acceptable (B. Landström, 1970, chapt.1; J. Hornell, 1946; M. Bonino, 1982, p. 76), but they are not fit for routine medium or long distance trips, nor to carry people and goods across the sea.

Tools from the Sardinian Neolithic period represent a level compatible with the main operations involved in timber boatbuilding: breaking the logs in regular boards, cutting to dimensions with adzes, carving, boring holes, smoothening (A. Leroi Gourham, 1993. P. 42, 121, 127; S. Mc Grail, 1981, p. 14). Moreover the distribution of obsidian from Mount Arci shows the need to sail with boats stronger than the reed rafts, although in some cases also reed canoes could have been used for small distance trips.

The following Neolithic comparisons are valid, although spread along a wide spell of time:

Bracciano lake models and dugouts (ab. 5250 B. C.) (M.A. Fugazzola Delpino, 1993, 1995).

Grabak graffito on a vase found in Hvar, Croatia (IV Mill. B. C.) (M. Bonino, 1988, 1993).

Neolithic tools used locally and generally, to perform the necessary operations.

Other comparisons allow to clarify the technical level and possible building details: The general run of the technical history of boats in Italy and in the Mediterranean (M. Bonino, 1981), to begin with rafts and to end with *sutiles naves* (M. Bonino, 1989).



An image from the dolmen in Antelas, Oliveira de Frades (Portugal VI-V mill. B.C.) is simple and far from our areas, but it recollects Grabak vase (F. Alonso Romero 1993).

Hierakompolis and Naxos models (L. Basch, 1987, N. 67 and 153-156), Kastorìa documents (Ch. Marangou, 2003) around the III mill. B.C.

Remembrances of archaic techniques in later times, like the block ends and the lack of symmetry of the shell planks of the boat F of Pisa (R. Bockius, 2003 and personal survey).

In the past I proposed to extend the concept of the coracle to the Grabak boat (M. Bonino, 1993, L. Basch, 1987, N. 132 – 145), but a plank hull now appears more promising.

Then, if we want to take the main shape from Bracciano models and Grabak graffito and complete it with the above elements, the boat may well have been built on the basis of a central strake, around which the shell was mounted (J. Hornell, 1946, Pl. XII). Parts of the shell can still keep the dugout structure, being possible that half dugouts were fastened aside the main strake; at the ends blocks ensured the consistency of the shell: in a model from Bracciano (M. A. Fugazzola Delpino, 1993, Tav. XVI, XVII) the blocks clearly ended up with a post and in the Roman boat F of Pisa we still have the blocks made with the same purpose and structural result; in Grabak the stern block ended with a large round post. For the connections between the shell and the inner structures different hypotheses are possible: from a virtual lack of structures (excepting upper transverse frames or benches), to different patterns of bottom frames and futtocks having cavities connected with blocks carved on the shell strakes. Details of the first Bracciano dugout (M. A. Fugazzola Delpino, 1995, fig. 15, 20-23, Tav. XIII) confirm the possibility to obtain in Neolithic times good supports to contrast both compression and tension, with a quite developed masonry capable to fix either the benches inside or structures outside the hull. Benches or upper transverse beams could have been protruding through mortices on the sides or leaning against supports similar to the mobile ones found in Bracciano Lake and fastened with lashings and pegs. Connections between the strakes composing the shell could have been performed with sewings through sufficiently small holes and good mortices; holes must not be wider than 8-10 mm in diameter, otherwise sewing could not be performed safely enough and I think this is the discriminating aspect of boatbuilding at that time. Neolithic tools allowed to drive such holes, provided the point was made of bone or of a small enough silex point, and some of the available documents show that this is the case. Sewings were most probably visible from outside, like those of the wales of Sardinian boats and e.g. of the Ferriby I boat (S. Mc Grail, 1981, pl. 11, pl. 31 for comparison), as I consider the oblique holes keeping the lashings inside the hull as a development, not necessarily present in the Neolithic.

In Grabak two rectangular objects are represented above the hull describing most probably a double tent hanging from a horizontal pole which needed at least four vertical props; in Predynastic Egyptian figures such double objects were, instead, small cabins (B. Landström, 1970, p. 12-13, 20-21). The proposed dugout-like structure of the parts composing the shell allows for cavities inside to lodge these vertical props, as suggested also by the two small holes corresponding to the position of the protruding supports of Bracciano dugout. Propulsion was most probably performed by means of paddles; sail is

suggested by the the Antelas dolmen, but in our areas there are no clues for them, in Egypt they are present from the IV and the III mill. B.C. respectively (B. Landström, 1970, chapt. 1, 2; L. Basch, 1987, p. 49-50, N. 79).

The results of these hypotheses are formalized in fig. 7, which is not a reconstruction, but a suggestion how the technical level could have been between the VI and the IV millennium B.C.

#### HYPOTHESES ON CALCHOLITHIC AND EARLY BRONZE AGES

For the Calcholithic period, we have indirect clues for the capability to build timber boats, as woodwork is represented in the *domus de janas*, with the reproduction of the structures of the roofs of the houses, like in S. Andrea Priu, Bonorva and Noeddàle, Ossi (G. Lilliu, 1967, p. 115-118, f. 20, 21, pl. IX, b ; G. M. Demartis, 1997).

In addition to the tools for working the wood, we must consider that boatbuilding needed a geometric approach to form and to control the shapes; the boatbuilder needed to control:

- the straightness of the middle line,
- that the two halves had the same breadth and curve,
- the shape of the profile,
- the shape of the main cross section.

If the boats were small, they were quite elementary, but if they exceeded about 8 to 10 m in length, these controls must have been achieved with geometrical tools, like a string, the ruler and the square, similar to those used in civil buildings.

The control of straight lines appears evident in some *tombe dei giganti* (Exhibition, 1985, p. 140, 141, 144, 147, 156, 157, 158, 169, 171), where this control is extended to lengths from 9 to 12 metres.

Control of the symmetry of buildings can be induced in some *domus de janas*: in the *Domu III* in Anghelu Ruju (Alghero) the control of symmetry is evident around a long straight line and in the *Tomba del Capo* in S. Andrea Priu, Bonorva (SS) the symmetry is even developed around the main three rooms and a centre line of about 15 m (G. Lilliu, 1967, fig. 18,3, fig. 122; Exhibition, 1985, fig. 4, p. 23). Precisions of these symmetries are obviously relative to the metrologic tools available at those times, but their plans show evident efforts to obtain rational layouts.

We see the trials to draw regular round shapes, using a string like a compass, in Arzachena circles and more frequently in later times like in Li Muri, in the *Tomba dei Giganti* in Coddù Vecchiu, in Ozieri and Santu Antine, Tav. IV, b, (Exhibition, 1985, p. 26, fig. 9; p. 139, 140, fig. 8, fig. 13, fig. 14).

In many of the foundations for the nuraghe and for dwellings we see clearly the usage of a string to draw a regular circle, the building technique with dry-stone walls could have resulted in more irregular surfaces than planned, due to the usage of the available stones. Therefore even if the builder had a clear idea of the geometry of his work and a circle was drawn on the ground, the result may have been more irregular.

Combination of the above two aspects were the controls of polygonal figures, beginning with the simplest (the rectangle).

Civil buildings reached a higher level of geometric control during later times, according to a generally spread geometrical culture, similar to that of the Etruscans in

planning the building (M. Bonino, 1997), but in Sardinia the circle and its applications were not much used.

Tools have been found in layers between Ancient and Middle Bronze (about 1500 B.C., G. Lilliu, 1967, p. 176, f. 28), showing the use of axes, axles and chisels. Later comparisons (bronze fragments of tools of the Late Bronze Age in the nuraghe of Sa Mandra 'e Sa Giua, Ossi (F. Lo Schiavo, 1997) are direct with bronze finds in Greece (Bronze Age: K. Braingan, 1974, p. 21 ff., pl. 14, 15) and, later, in continental Italy (Bologna: M. Cristofani, 1985, 2.8.3, p. 73-74). In these cases woodworking is much improved, with new tools, such as saws, files and more accurate chisels and drills, betokening techniques substantially similar even to those used in Roman times.

The existence of a nautical building background is also hinted by a series of grafitoes and engraving, dated around 2000 to 1300 B.C., unfortunately not very clear, but confirming the usage of seagoing crafts: the capability to draw developed much later than that of building boats and ships, therefore the figures from Tarxien, Thapsos (L. Basch, 1987, N. 819, 821), S. Vito lo Capo (A. Guidi, M. Piperno, 1993, p. 337; F. Torre, 1998, p. 219), and then up to Laja Alta, in Andalusia (C. Aubert, 1999, fig. 2 – 9), are not indicative enough. Some shapes common to Minoan and Mycenaean types can be recognized (see fig. 5B and L. Basch, 1987, f 8, 235, 284, 298) and even, in Laja Alta, we see the tentative to represent the backward optical plan, by collapsing it, like in the Mycenaean and Greek geometric pictures (M. Bonino, 2000, p. 524); but the quality of these drawings does not allow us to draw many technical conclusion: the discussion is open.

#### EARLY ETRUSCAN DOCUMENTS

Clay models from Villanovan areas, mainly Tarquinia, Cerveteri and Vetulonia, are dated generally from the IX to the VII Century B.C.: they are more recent than the Sardinian models, some of which still circulated at that time as status symbols and were put in tumbs or temples, like in Vetulonia, in Gravisca or in Hera Lacinia (R. Spadea, 1996).

The quality of these terracotta objects is much worse and more idealized than that of the Sardinian bronze models, therefore deductions regarding the original aspects of the ships are more questionable. The fact is that the translation from bronze to terracotta was the consequence of a different interpretation of the figure of the ship and the resulting objects had less connections with the original models. I mentioned the possible path from flat bottomed shapes of Sardinian crafts to the jug-like shapes of the correspondent Villanovan (or better early Etruscan) specimen. Other distortions or approaches to the shapes resulted in idealization which are evident on the Bisenzio vase, to end with the Artimino censer (M. Cristofani, 1985, 3.9 p. 99).

Even keeping in mind these visions and distortions, some basic features of the ships can be deduced, ending up with a tentative classification of the types:

ship with protruding keel at the ends, moved by oars and sail, similar to the Mycenaean type; although the Mycenaean (or the celebrated Medinet Habou: E. D. Orew, curator, 2000; L. Basch, 1987, p. 66-69, N 299) comparisons are more ancient than these Villanovan ships, the type is by sure similar. Mainly a model in Tarquinia, the most realistic one, gives good tools for this reconstruction (M. Bonino, 2000). (Fig. 8 A)

round ended oared ships with the *akrostolion* ending with a duck head (or other more emblematic animal, like the gryphon) (G. Hencken, 1968, 1-48, f. 17, 76, 2-410 f. 410, 2-fig. 329 c, 332; L. Basch, 1987, N. 840-842, 844), fig. 8 B, smaller version of the above, with oars only (M. Cristofani, 1985, 2.10.5, p. 63), fig. 8 C,

double ended craft, similar to the Mycenaean types of the small terracotta of the National Museum in Athens (L. Basch, 1987, N 292, 293), with perpendicular posts, mainly represented by the terracotta from Bisenzio (G. Pettena, 1997, Columbia University, NY, Inv. N: PE 26.233). Here we can recollect the Hagia Triada terracotta model mentioned before (fig. 8 D).

flat bottomed crafts, with round sides and carefully shaped ends; these hulls appear to have developed from previous flat bottomed crafts, shaping round sides (A. Göttlicher, 1978, NN. 442, 444): a process similar to that we saw on Nuragic flat bottomed bronze models (figs. 1.B, 2). In the bucchero N 444 (Göttlicher, pl. 34, p. 77) a keelson is hinted, showing a strong structure. These boats were used also in the VII-VI Cent. B.C. (M. Bonino, 1981; A. Göttlicher, 1978, N.443, 457), fig. 8 E.

While Sardinian models show the repetition of basically two shapes, in early Etruscan ambient we see a higher degree of specialization, and therefore of usages, even if the technique of representation is much poorer. There is also a higher degree of connection with the Aegean world, so much that in the VII cent. the *pentekonteroi* of the early Attic figures are represented also in Tarquinia, or at least we see a common technical background.

In Etruscan times woodworking and the geometric tools to build and to control the measures and the shapes of a ship were consolidated, while the building technique had most probably a continuity with the archaic technique of the *sutiles naves*. However Homer's mention, the technical needs of the *pentekonteroi* and the nature of the Greek wrecks of the VI – V cent. B.C. (P. Pomey, 2001) show the usage of tenons and pegs connections of the shell, sometimes still together with the old sewings; the bireme of the tumbstone of Vele Caicne in Bologna (V Cent. B.C, M. Bonino, 1988, fig. 7, p. 77) has a multiple wale under the floating line, which is the first example of a typical structure of Hellenistic and Roman times. Between these techniques we have an example of tenons and pegs connection as old as the VII – VI cent. B.C. found in Verucchio (Rimini); in the tumb N. 89 precious and nicely carved wooden artifacts were contained in a case made of oak boards (G. V. Gentili, 2003, p. 28, 293 – 302, fig. 57-58, Pl. XI, c and personal checks), which were connected with tenons and pegs, similar to those used in boatbuilding (fig. 9). For this period in Italy we generally consider that the «normal» boatbuilding technique was that of the *sutiles naves*, like that of Bon Porté or that proposed for the Sardinian ships. This tenons and pegs connection in Verucchio puts two questions:

was the tenon and pegs technique used normally on land buildings, while ships continued to be built with the old stitching technique?

was tenon and pegs technique used by Villanovian and Etruscan culture in some boats, even though later it was called *punicanum coagmentum*? (Cato, *De Agricultura*, 18,9).

Both questions can be answered in the positive, for the first case we have to consider that boatbuilding was rather conservative, on the other hand the first documents of tenons and pegs technique range from the XIV Cent. B.C (R. Steffy, 1987, fig. 3.15) to Homer's description in the *Odyssey*; therefore during the VIII – VII cent. it could have

been well known also in areas where older building methods were still used, as trade allowed different building traditions come into contact. The Latin name for this technique suggests a Phoenician or Carthaginian channel, but more data are needed to clarify our ideas.

Bologna, September 2004

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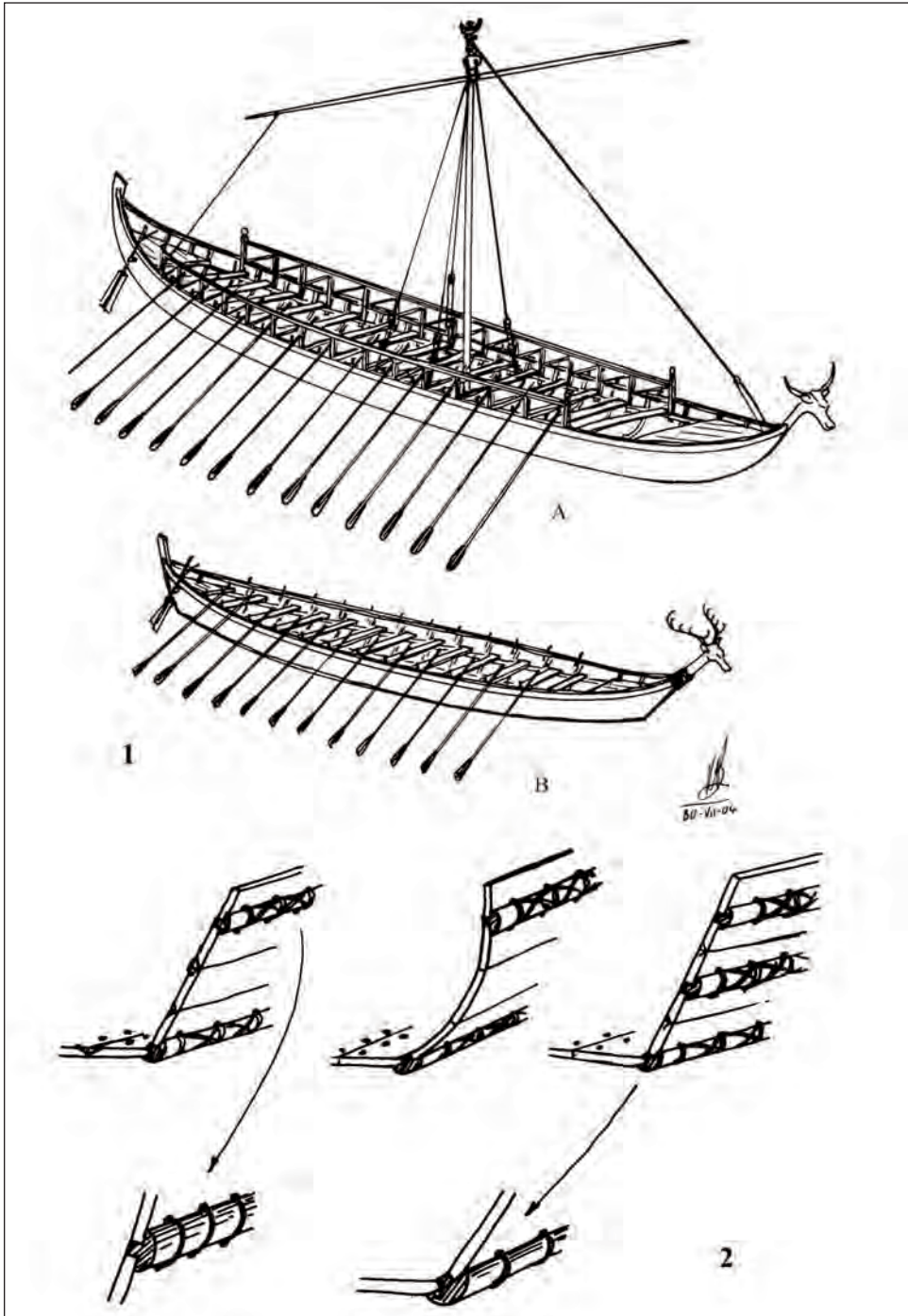


Fig. 1: (A) Sardinian oared and sailing ship with round shaped hull, from Nuragic bronze models. (B) Sardinian oared ship with flat bottomed hull, from Nuragic bronze models. Fig. 2: Flat bottomed Sardinian hulls: details of the connections with single and multiple wales.

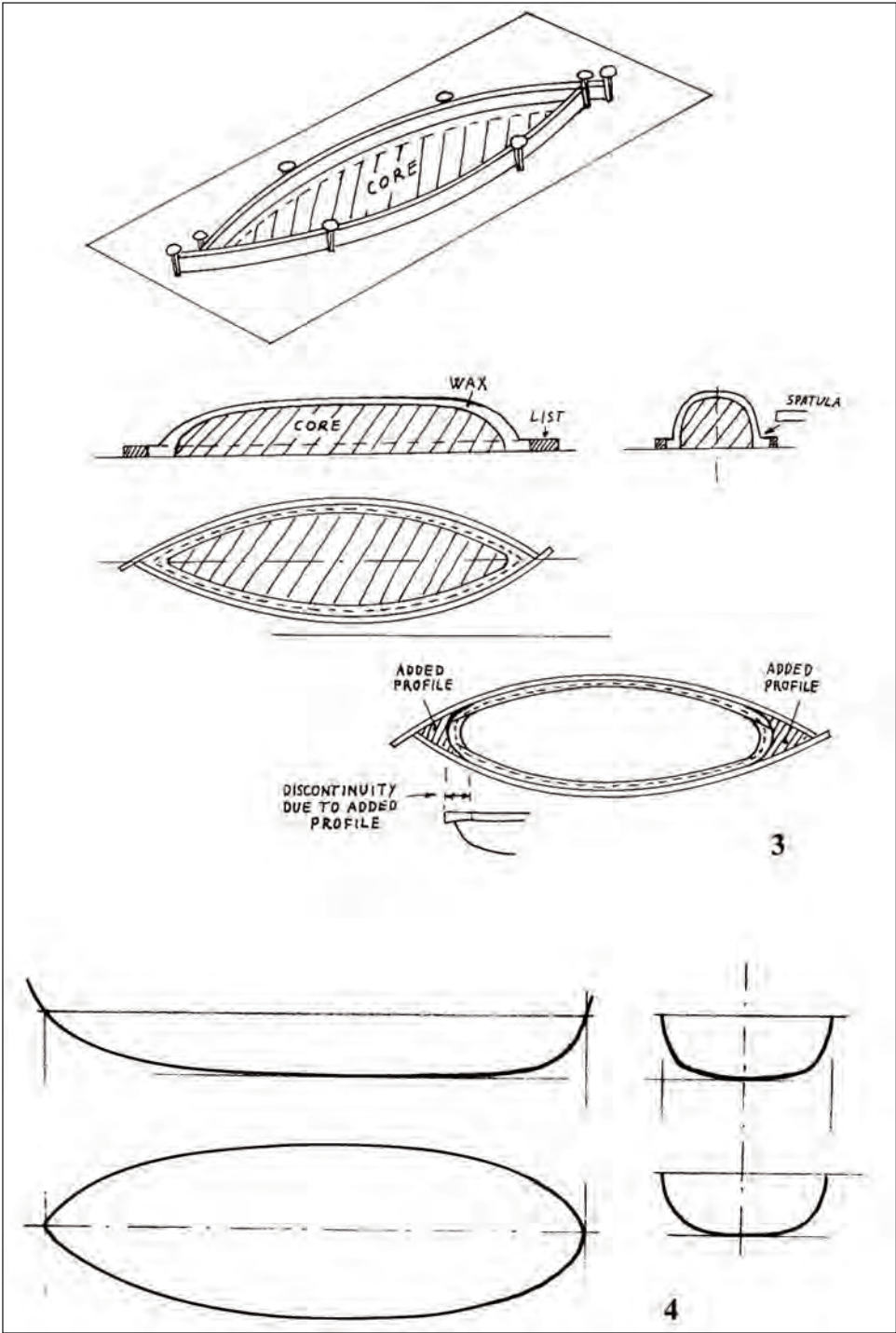


Fig. 3: Shaping the mould for nuragic bronze models with wooden lists. Fig. 4: Lines of a round hull of a Sardinian ship with wide hull and perpendicular posts.

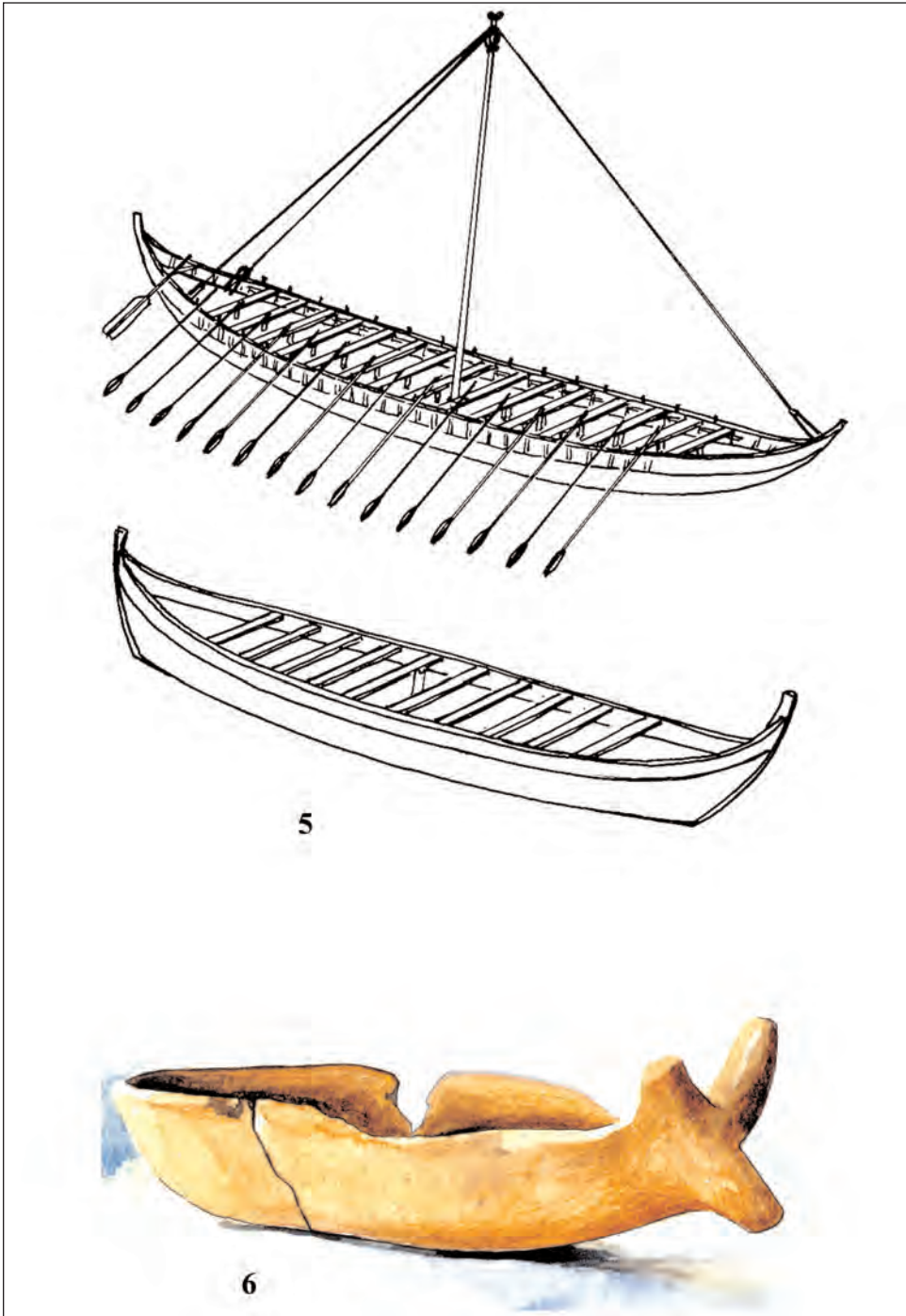


Fig. 5: General shapes of some Minoan crafts (Hagia Triada sarcophagus and clay model). Fig. 6: Terracotta in shape of a ship, from the nuraghe of Su Mulinu (VII cent. B.C.), card of Villanovafranca Museum.

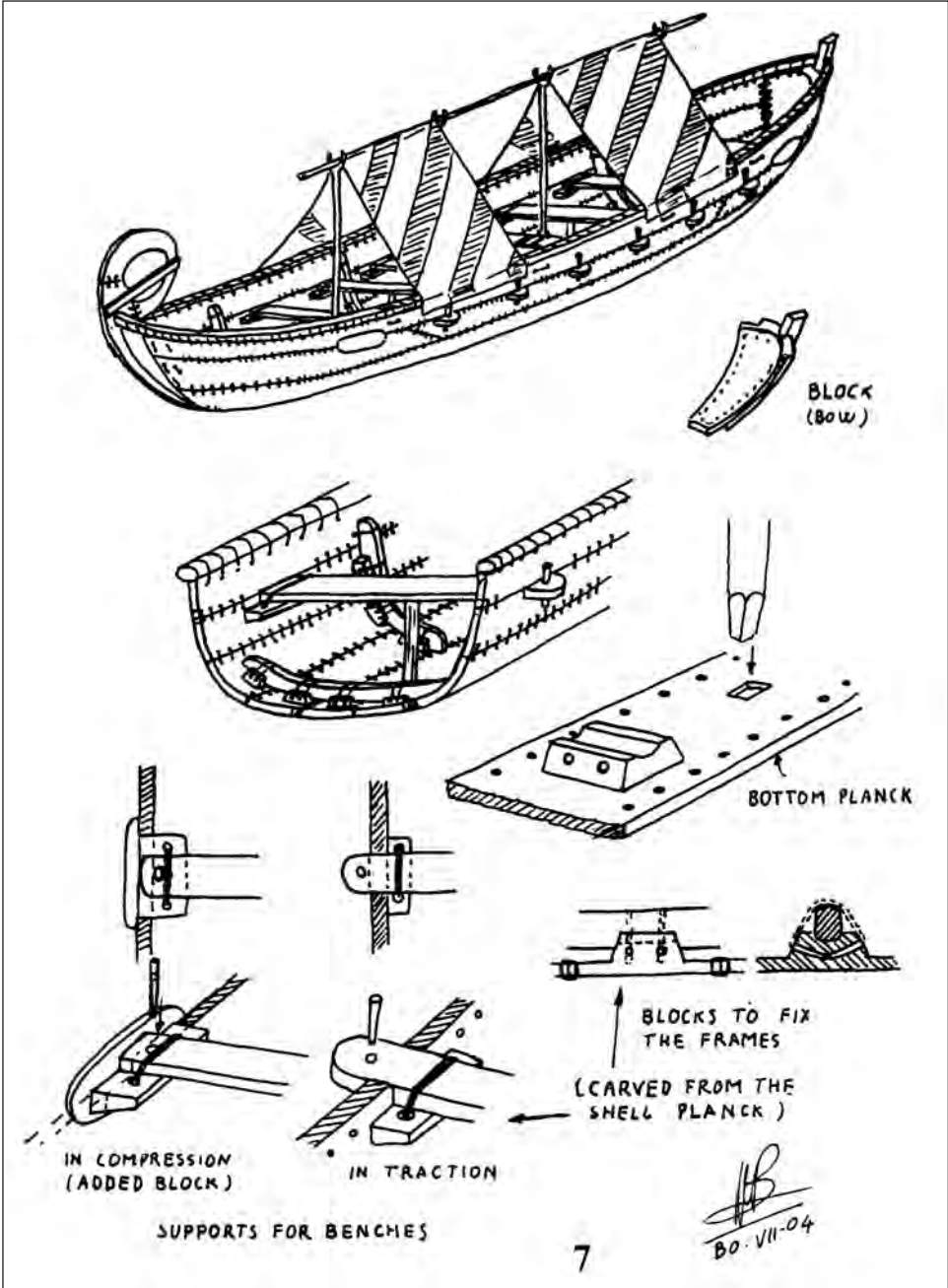


Fig. 7: Technical level of a Neolithic boat, around the IV Mill. B.C.



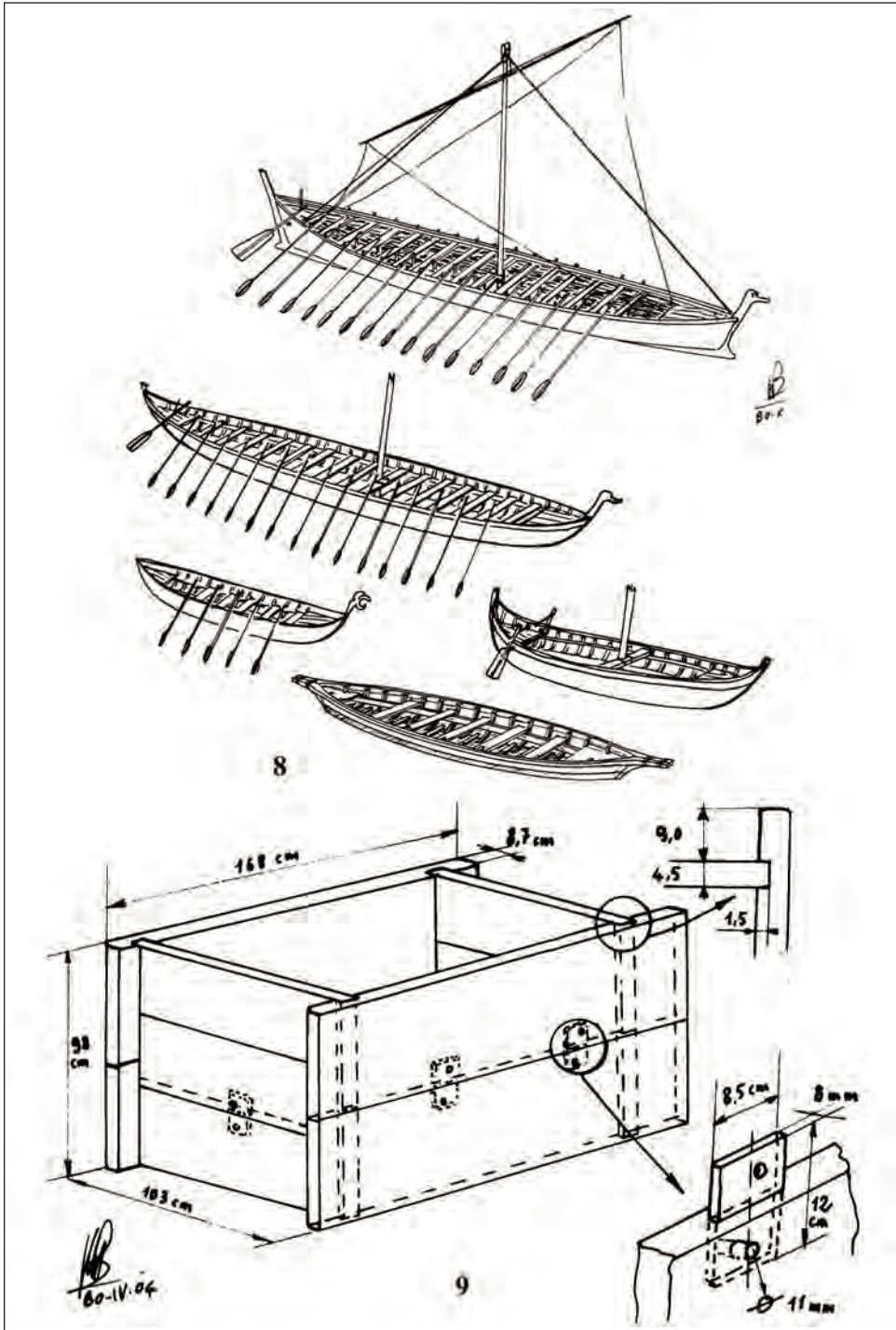


Fig. 8: Villanovian or early Etruscan types. Fig. 9: Tenons and pegs connection of a wooden case from Verucchio (VII–VI cent. B.C.).